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Dynamic Buffer Zone (DBZ) System Performance

INTRODUCTION

The brick veneer steel-stud (BVSS) system is a popular exterior wall for apartments and condominiums. In the past 20 years, there have been concerns about the system's long-term serviceability and durability. This study, by Keller Engineering and Associates (KEA) Inc., is one of several CMHC research projects that have studied the performance and durability of BVSS systems.

The study was the fifth phase of a project monitoring and recording BVSS exterior wall performance to better understand the long-term conditions of the cavities and the effects of the conditions on the steel-stud system.

Previous phases found that it is almost impossible to completely prevent air leakage and cavity condensation, no matter what remedial measures designers and builders applied. Remedial measures included better construction, improved air barrier details and improved venting and drainage of brick cavities. None was satisfactory. Condensation continued within wall cavities in winter.

CMHC contracted KEA to evaluate a new condensation control method that combines architectural modifications and mechanical ventilation, called the "Dynamic Buffer Zone" (DBZ) concept.

Simply put, dry (cold) outdoor air is heated and pumped into the wall cavities of the exterior wall until the cavity pressure rises slightly above indoor air pressure. This pressure increase theoretically reverses the flow of air leakage through the exterior wall, preventing humid, warm indoor air from entering the exterior wall and condensing in the cavity.

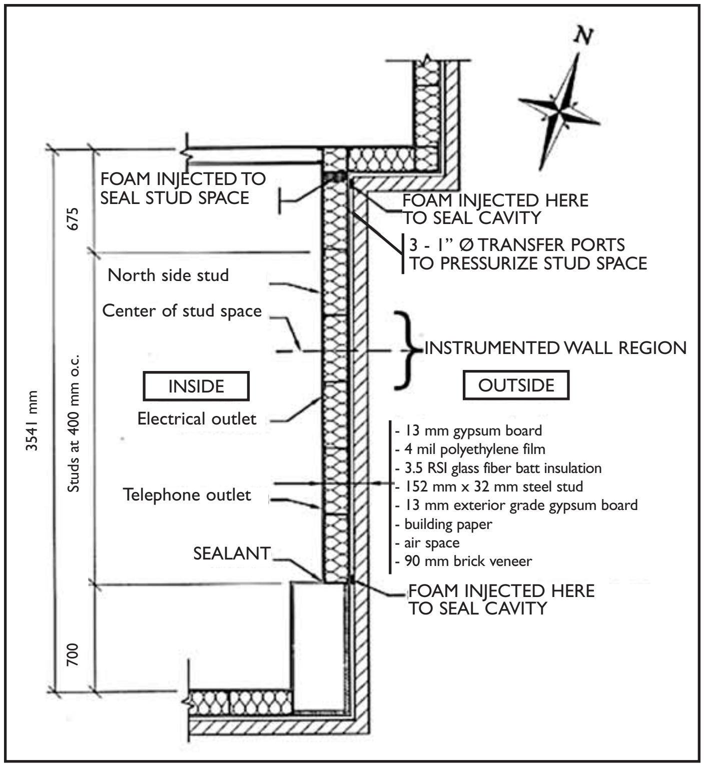

Figure 1 Plan view of test wall

OBJECTIVES

KEA monitored the performance of a DBZ system under various operating conditions during four, six-week periods between April 2000 and February 2001, for four weeks in February and March 2002 and three, two-week periods between December 2002 and March 2003.

The monitoring evaluated the DBZ's performance under different operating conditions, such as partial pressure distribution, no heat, indoor and outdoor air supplies, and so on.

Researchers hoped to answer, among other things, the following questions:

- Does a DBZ system control or prevent condensation moisture from accumulating in wall cavities in winter?
- How complicated is it to design and built a functional DBZ system?
- What operating conditions influence DBZ performance?
- What are the advantages and disadvantages of a DBZ system?

THE TEST WALL

For this study, KEA selected a wall area facing east at the top floor of a seven-storey apartment building in Ottawa. The test wall, on the exterior of a bedroom, was constructed of:

- 13 mm gypsum board
- 4 mil polyethylene film
- RSI 3.5 glass fiber batt insulation
- 152 mm x 32 mm steel stud
- 13 mm exterior grade gypsum board
- building paper
- air space
- 90 mm brick veneer

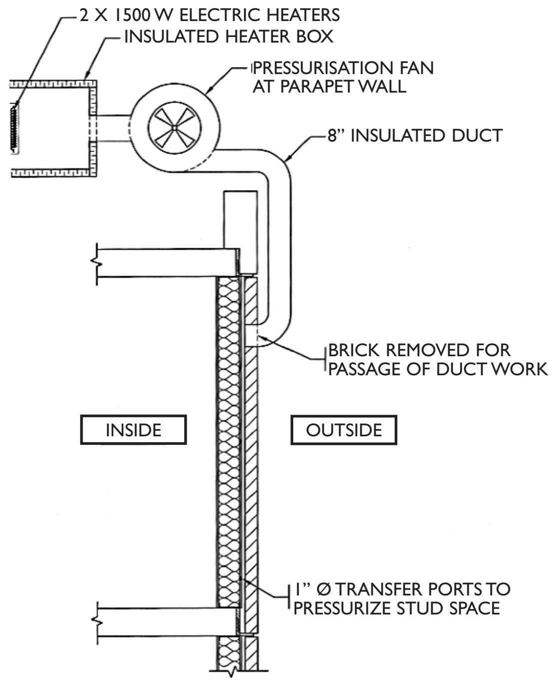

Figure 2 Schematic layout of pressurization fan system

THE DBZ SYSTEM

KEA designed and built a simple, two-part DBZ system—an architectural fit-up and a mechanical ventilation fit-up.

The architectural fit-up isolated the cavity behind the brick veneer and the cavity of the steel stud of the exterior wall at both ends of the test wall. In both cases, the researchers opened the exterior wall and blocked and sealed the cavities with foamed-in-place polyurethane insulation. To further prevent undue loss of pressure, KEA also blocked and sealed the weepholes in the brick veneer.

The mechanical fit-up consisted of a 200 mm diameter in-line duct pressurization fan on the roof, a heater for the supply air and insulated ductwork from the DBZ fan to the exterior wall through an exterior brick opening. The system also had a variable speed controller and switches for the heater and fan. The full report[1] gives a complete description of the construction and mechanical system.

Researchers turned the fan on in the fall, adjusted the cavity pressure 5 to 10 Pa above the indoor pressure, ran the fan over the winter and turned it off in late spring.

1 *Performance Monitoring of a Brick Veneer/Steel Stud Wall System. Phase 5: Study of a dynamic buffer zone (DBZ) system.* Available from the Canadian Housing Information Centre 1 800 668-2642 (outside Canada, dial 613 748-2003) or at our website www.cmhc-schl.ca

INSTRUMENTATION

The researchers used temperature, moisture and air pressure sensors connected to a computer-based, automatic data acquisition system. They installed the data acquisition system and sensor accessories in the mechanical penthouse on the roof and measured air and surface temperature with thermocouples within and outside the test wall. Relative humidity sensors in and outside the test wall measured water vapour in the air. Air pressure was measured in the test wall with pressure taps (open-ended tubes) leading from the wall cavities, indoor and outdoor, to electronic manometers in the mechanical penthouse. Ottawa International Airport weather data was used to record local weather conditions.

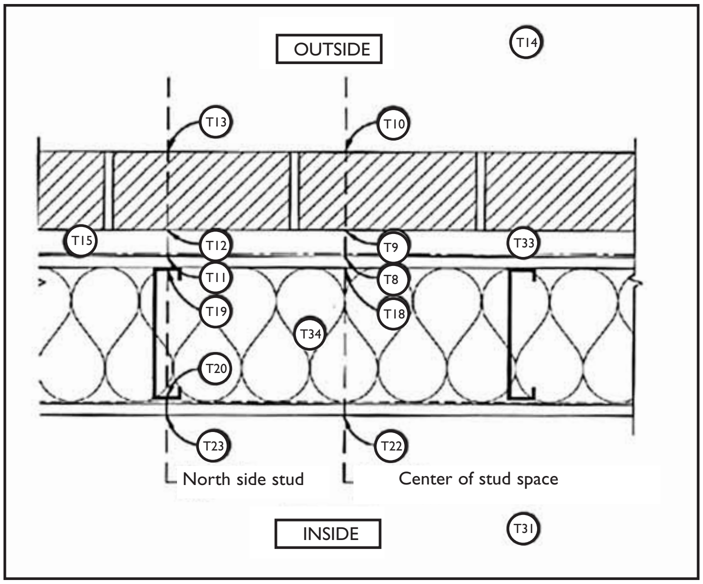

Figure 3 Locations of thermocouples across test wall

MONITORING PROCEDURE

The exterior wall with the DBZ system was monitored and adjusted as needed over the three years of the study, from August, 2001 to March, 2003.

From August, 2001 to March, 2002, air was drawn directly from the exterior at the parapet wall above the test location. Only the unpressurized case for this time period is documented in the report.

From December, 2002 to March, 2003, the outdoor air was pre-heated with two, 1,500 W electric heaters. The researchers also made transfer ports (holes cut in the gypsum board sheathing) between the cavity air space behind the brick veneer and the stud space to allow pressurization of the stud cavity.

OBSERVATIONS AND RESULTS

- In cold weather, when the wall was pressurized by the DBZ system, there was little or no condensation on the backside of the brick veneer.
- Similarly, there was no condensation on the interior face of the exterior gypsum board sheathing.
- There was no condensation on the steel studs at any time.
- The interior of the brick veneer at the slab level was often wet in winter. Condensation did not seem to be the moisture source in any weather-related conditions. However, when wetted by precipitation, the base of the brick veneer remained wet for long periods.

CONCLUSIONS AND RECOMMENDATIONS

This study shows that the DBZ system can prevent and control wall condensation and related moisture damage. It appears to function because the higher cavity pressure prevents indoor air from entering the wall cavity through imperfections in the wall system components and—in particular—air barrier discontinuities. The system maintains the cavity air at a dew point temperature well below the outdoor temperature.

The study expresses concern about the sealing of the weeps and vents in the brick cladding as the rainscreen effect may be compromised. The study proposes the following:

- Install small drains at the base of the brick veneer wall to create a path for rain-penetration moisture to escape through the drains to the outside.
- If DBZ operates in summer, the supply air may require dehumidification to prevent indoor side condensation, particularly during air conditioning periods.
- There should be a study of the energy cost of the operation and the cost saving from the reduction in building exfiltration to determine the actual cost of operating the system.
    - First, it must be understood that when a wall cavity is pressurized, the exfiltration of indoor air is interrupted and therefore heat loss is reduced. This will result in a saving.
    - Second, while a fan-operation energy audit is relatively simple, calculating the cost of heating the air is not. This is because a heater will turn on and off according to load (outdoor temperature), that is, off on sunny, windless days, and cycle according to thermostat settings. The only practical way to evaluate this energy is with an in-line, kilowatt-hour meter. KEA notes that such a project must be designed carefully by both a mechanical engineer and a building scientist aware of the energy aspect of air exfiltration.

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